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PATENT APPLICATION
09/853,323

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**In The United States Patent and Trademark Office
On Appeal From The Examiner To The Board
of Patent Appeals and Interferences**

In re Application of: Takeshi (nmi) Hoshida et al.
Serial No.: 09/853,323
Filing Date: May 10, 2001
Group Art Unit: 2633
Examiner: Agustin Bello
Title: Method and System for Transmitting Information in an
Optical Communication System Using Distributed
Amplification

Mail Stop: Appeal Brief - Patents
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Willie Jiles

Willie Jiles

Date: November 2, 2005

Appeal Brief

Appellants have appealed to the Board of Patent Appeals and Interferences from the decision of the Examiner mailed August 10, 2005, finally rejecting Claims 1-26, all of which are pending in this case. Appellants filed a Notice of Appeal on September 6, 2005. Appellants respectfully submit this Appeal Brief with the statutory fee of \$500.00.

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Table of Contents

Real Party In Interest	3
Related Appeals and Interferences	4
Status of Claims	5
Status of Amendments	6
Summary of Claimed Subject Matter	7
Grounds of Rejection to be Reviewed on Appeal	10
Argument	11
I. The Examiner's Rejection of Independent Claims 1-6, 8-9, 11-18, 20-21, and 23-24 is Improper	11
II. The Examiner's Rejection of Claims 7, 10, 19, 22 and 25 is Improper	16
III. The Examiner's Rejection of Claim 26 is Improper	18
Conclusion	19
Appendix A: Claims on Appeal	20
Appendix B: Evidence	28
Appendix C: Related Proceedings	29

Real Party In Interest

This application is currently owned by Fujitsu Limited, as indicated by an assignment recorded on April 1, 2002, in the Assignment Records of the United States Patent and Trademark Office at Reel 012772, Frames 0934-0938.

Related Appeals and Interferences

There are no known appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision regarding this appeal.

Status of Claims

Claims 1-26 are pending in this application. Claims 1-26 are rejected pursuant to a final Office Action mailed August 10, 2005, and are all presented for appeal. All pending claims are shown in Appendix A.

Status of Amendments

No claims from the original application have been amended.

Summary of Claimed Subject Matter

FIGURE 1 of the application illustrates an optical communication system 10 in accordance with one embodiment of the present invention. In this embodiment, the optical communication system 10 is a wavelength division multiplexed (WDM) system in which a number of optical channels are carried over a common path at disparate wavelengths. The WDM system 10 includes a WDM transmitter 12 at a source end point and a WDM receiver 14 at a destination end point coupled together by an optical link 16. The WDM transmitter 12 transmits data in a number of optical signals, or channels, over the optical link 16 to the remotely located WDM receiver 14. (Page 9, lines 2-17).

The WDM transmitter 12 includes a number of optical senders 20 and a WDM multiplexer 22. Each optical sender 20 generates an optical information signal 24 on one of a set of distinct wavelengths. The optical information signals 24 comprise optical signals with at least one characteristic modulated to encode audio, video, textual, real-time, non-real-time or other suitable data. The optical information signals 24 are multiplexed into a single WDM signal 26 by the WDM multiplexer 22 for transmission on the optical link 16. (Page 9, line 27 – Page 10, line 4).

The WDM receiver 14 receives, separates and decodes the optical information signals 24 to recover the included data. In one embodiment, the WDM receiver 14 includes a WDM demultiplexer 30 and a plurality of optical receivers 32. The WDM demultiplexer 30 demultiplexes the optical information signals 24 from the single WDM signal 26 and sends each optical information signal 24 to a corresponding optical receiver 32. Each optical receiver 32 optically or electrically recovers the encoded data from the corresponding signal 24. (Page 10, lines 9-18).

The optical link 16 comprises optical fiber or other suitable medium in which optical signals may be transmitted with low loss. Interposed along the optical link 16 are one or more optical amplifiers 40. The optical amplifiers 40 increase the strength, or boost, one or more of the optical information signals 24, and thus the WDM signal 26, without the need for optical-to-electrical conversion. In one embodiment, the optical amplifiers 40 comprise discrete amplifiers 42 and distributed amplifiers 44. The discrete amplifiers 42 comprise rare earth doped fiber amplifiers, such as erbium doped fiber amplifiers (EDFAs), and other

suitable amplifiers operable to amplify the WDM signal 26 at a point in the optical link 16. (Page 10, lines 21 – Page 11, line 2).

The distributed amplifiers 44 amplify the WDM signal 26 along an extended length of the optical link 16. In one embodiment, the distributed amplifiers 44 comprise bi-directional distributed Raman amplifiers (DRA). Each bi-directional DRA 44 includes a forward, or co-pumping source laser 50 coupled to the optical link 16 at a beginning of the amplifier 44 and a backward, or counter-pumping source laser 52 coupled to the optical link 16 at an end of the amplifier 44. (Page 11, lines 3-11).

The amplification signal from the co-pumping laser 52 is launched in the direction of travel of the WDM signal 26 and thus co-propagated with the WDM signal 26 at substantially the same speed and/or a slight or other suitable velocity mismatch. The amplification signal from the counter-pumping laser 52 is launched in a direction of travel opposite that of the WDM signal 26 and thus is counter-propagated with respect to the WDM signal 26. The amplification signals may travel in opposite directions simultaneously at the same or other suitable speed. (Page 11, lines 23-33).

A non-intensity characteristic of a carrier signal is modulated with the data signal at each optical sender 20. The non-intensity characteristic comprises phase, frequency or other suitable characteristic with no or limited susceptibility to cross talk due to cross-gain modulation (XGM) from a forward pumping distributed amplifier or a bi-directional pumping distributed amplifier. The non-intensity modulated optical information signal may be further and/or remodulated with a clock or other non-data signal using an intensity modulator. Thus, the non-intensity modulated optical information signal may comprise intensity modulation of a non-data signal. (Page 12, lines 15-27).

In a particular embodiments, the WDM signal 26 comprises phase or frequency modulated optical information signals 24 which are amplified using the bi-directional DRAs 44 with no cross talk between the channels 24 due to XGM. In this embodiment, the bi-directional DRAs 44 provide amplification at a superior optical signal-to-noise ratio and thus enable longer transmission distances and improved transmission performance. (Page 12, line 28 – Page 13, line 3).

FIGURE 9 illustrates a method for transmitting information in an optical communication system using distributed amplification in accordance with one example

embodiment of the present invention. In this example embodiment, data signals are phase-shift keyed onto the carrier signal and the signal is amplified during transmission using discrete and distributed amplification. The method begins at step 140 in which the phase of each disparate wavelength optical carrier signal is modulated with a data signal 74 to generate the optical information signals 24. At step 142, the optical information signals 24 are multiplexed into the WDM signal 26. At step 143, the WDM signal 26 is transmitted in the optical link 16. (Page 19, lines 18-31).

Proceeding to step 144, the WDM signal 26 is amplified along the optical link 16 utilizing discrete and distributed amplification. As previously described, the WDM signal 26 may be amplified at discrete points using EDFAs 42 and distributively amplified using bi-directional DRAs 44. Because the data signals are modulated onto the phase of the carrier signal, cross talk between channels from XGM due to forward pumping amplification is eliminated. Accordingly, the signal-to-noise ratio can be maximized and the signals may be transmitted over longer distances without regeneration. (Page 19, line 32 – Page 20, line 9).

Next, at step 145, the WDM signal 26 is received by the WDM receiver 14. At step 146, the WDM signal 26 is demultiplexed by the demultiplexer 30 to separate out the optical information signals 24. At step 147, the phase modulated optical information signals 24 are converted to intensity modulated signals for recovery of the data signal 74 at step 148. In this way, data signals 74 are transmitted over long distances using forward or bi-directional pumping distributed amplification with a low bit-to-noise ratio. (Page 20, lines 10-19).

Grounds of Rejection to be Reviewed on Appeal

Appellants request that the Board review the Examiner's rejection of Claims 1-6, 8-9, 11-18, 20-21, and 23-24 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,310,709 issued to Bergano ("*Bergano '709*") in view of U.S. Patent No. 6,417,958 issued to Du et al. ("*Du*"). Furthermore, Appellants request that the Board review the Examiner's rejection of Claims 7, 10, 19, 22, and 25 under 35 U.S.C. § 103(a) as being unpatentable over *Bergano '709* in view of *Du* and further in view of U.S. Patent No. 6,556,326 issued to Bergano ("*Bergano '326*"). Finally, Appellants request that the Board review the Examiner's rejection of Claim 26 under 35 U.S.C. § 103(a) as being unpatentable over *Du* in view of *Bergano '326*.

Argument

The Examiner's rejections of Claims 1-26 is improper, and the Board should withdraw the rejections for the reasons given below.

I. The Examiner's Rejection of Independent Claims 1-6, 8-9, 11-18, 20-21, and 23-24 is Improper

The Examiner rejects Claims 1-6, 8-9, 11-18, 20-21, and 23-24 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,310,709 issued to Bergano ("*Bergano '709*") in view of U.S. Patent No. 6,417,958 issued to Du et al. ("*Du*").

Claim 1 of the present Application recites the following limitations:

A method for transmitting information in an optical communication system, comprising:
modulating a non-intensity characteristic of an optical carrier signal with a data signal to generate an optical information signal;
transmitting the optical information signal over an optical link; and
amplifying the optical information signal over a length of the optical link with a co-launched amplification signal traveling in a same direction as the optical information signal in the optical link.

Independent Claims 13 and 23 recite similar, although not identical, limitations.

In order to establish a *prima facie* case of obviousness, three requirements must be met: (1) there must be some suggestion or motivation, either in the references themselves or in the knowledge available to one skilled in the art, to modify a reference or combine multiple references; (2) there must be a reasonable expectation of success; and (3) the prior art reference (or combination of references) must teach or suggest all of the claim limitations. M.P.E.P. § 2143. In the present case, a *prima facie* case of obviousness cannot be maintained for at least two reasons. Neither *Bergano '709* nor *Du* provides a suggestion or motivation to combine the references. Furthermore, even assuming for the sake of argument that the references did suggest or motivate a combination of the references to a person of ordinary skill in the art at the time of the invention, *Bergano '709* and *Du*, whether considered singly,

in combination with one another, or in combination with information generally available to those of ordinary skill in the art at the time of the invention, still fail to disclose all of the elements of the pending claims.

A. The References Do Not Disclose Each and Every Limitation of the Claims

First, *Bergano '709* and *Du* do not disclose each and every limitation of any of the rejected claims. For example, independent Claim 1 recites “modulating a non-intensity characteristic of an optical carrier signal with a data signal to generate an optical information signal.” Independent Claims 13 and 23 recite similar, although not identical, limitations. In the Office Action, the Examiner argues that this limitation is disclosed in *Bergano '709* (by elements 102 and/or 108 of Figure 1). However, Appellants respectfully submit that this is not the case. Element 102 of Figure 1 is a data modulator that “that modulates the signal to impart information in a *conventional* manner to produce a modulated optical information signal 103.” *Column 2, lines 28-32* (emphasis added). It also discloses that the data modulator “modulates the optical signal 101 *at a frequency* determined by a clock 106 via a clock signal on line 117.” *Column 2, lines 34-36*. The Examiner has argued that he believes that this means that frequency modulation is used. However, the fact that the modulator operates at a frequency indicates to Appellants that the frequency is *not* being modulated (since it operates at a single frequency). As an example only, Appellants own application happens to describe *intensity* modulating a signal with a clock frequency (see Page 14, line 30 -- Page 15, line 11 and Figure 4). In any case, *Bergano '709* certainly does not specifically disclose that data modulator modulates the data onto the signal using non-intensity modulation, as required by Claims 1, 13, and 23.

Furthermore, *Bergano '709* suggests that the “conventional” technique used by the data modulator to modulate the data onto the signal is *intensity* modulation.¹ See *Column 2, line 60 – Column 3, line 1*. However, the Examiner argues that frequency modulation is a

¹ The reference indicates that the electric field of the optical signal upon which the phase modulator 108 acts (i.e., the optical signal onto which data modulator 102 has modulated the data) is a function of the intensity modulation of the signal upon which phase modulator acts. This indicates that this signal has been intensity modulated and the only modulator that acted on the signal before the phase modulator 108 is the data modulator 102. Thus, the data modulator 102 must be an intensity modulator.

“conventional” modulation scheme. Applicants submit that there is no support in the cited references for this proposition (and, in fact, *Bergano '709* instead suggests that intensity modulation is being used). The Examiner appears to argue on page 7 of the Final Office Action that frequency modulation is a conventional modulation scheme “[g]iven that Applicant has failed to specify a conventional modulation scheme and given the broadest reasonable interpretation of a conventional modulation scheme.” Appellants have no duty to specify what *Bergano '709* means by modulating a signal in a “conventional manner” (as it appears the Examiner is implying). The burden is on the Examiner to prove that the claims are obvious based on the cited reference (although, in this case, Appellants have actually shown what *Bergano '709* means by “conventional manner” – intensity modulation). Furthermore, the Examiner is incorrectly applying a claim interpretation standard to the prior art by stating that he can expand the teachings of the prior art to their “broadest reasonable interpretation.” Again, in any case, *Bergano '709* does not disclose that data modulator modulates the data onto the signal using non-intensity modulation, as required by Claims 1, 13, and 23. Again, it suggests the opposite.

Furthermore, with respect to the Examiner’s argument that element 108 discloses the limitation at issue, although element 108 is a phase modulator that modulates a non-intensity characteristic of a signal, it does *not* modulate a carrier signal with a *data signal*, as required by the claims. As described above, it is the data modulator 102 that modulates an optical signal 100 with a data signal 116. Instead, the phase modulator 108 “modulates the phase of the optical carrier (i.e., optical signal 101) onto which the data signal has been modulated.” *Column 2, lines 37-40*. In other words, the phase modulator “receives an optical signal into which data has been modulated at a predetermined frequency.” *Abstract*. Therefore, the phase modulator disclosed in *Bergano '709* does not modulate a carrier signal with a *data signal*, as required by the claims. Instead, it further modulates a signal that already has the data modulated onto it.

Therefore, *Bergano '709* does not disclose “modulating a non-intensity characteristic of an optical carrier signal with a data signal to generate an optical information signal,” as recited in Claim 1, and as similarly recited in Claims 13 and 23. Furthermore, as the

Examiner recognizes, *Du* also does not disclose this limitation. Therefore, for at least this reason, the *Du-Bergano '709* combination does not disclose each and every limitation of any of the rejected claims.

B. There Is No Suggestion or Motivation to Combine the References

Second, there is no suggestion or motivation to combine *Du* and *Bergano '709*. The question raised under 35 U.S.C. § 103 is whether the prior art taken as a whole would suggest the claimed invention taken as a whole to one of ordinary skill in the art at the time of the invention. *See* 35 U.S.C. § 103(a) (2000). Accordingly, even if all elements of a claim are disclosed in various prior art references, which is certainly not the case here as discussed above, the claimed invention taken as a whole cannot be said to be obvious without some reason given in the prior art why one of ordinary skill at the time of the invention would have been prompted to modify the teachings of a reference or combine the teachings of multiple references to arrive at the claimed invention.

The M.P.E.P. sets forth the strict legal standard for establishing a *prima facie* case of obviousness based on modification or combination of prior art references:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references where combined) must teach or suggest all the claim limitations.

M.P.E.P. chs. 2142-43 (Rev. 2, May 2004). “To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. All words in a claim must be considered in judging the patentability of that claim against the prior art.” M.P.E.P. ch. 2143.03 (Rev. 2, May 2004) (citations omitted).

In addition, the M.P.E.P. and the Federal Circuit repeatedly warn against using an applicant’s disclosure as a blueprint to reconstruct the claimed invention. For example, the

M.P.E.P. states, “The tendency to resort to ‘hindsight’ based upon applicant’s disclosure is often difficult to avoid due to the very nature of the examination process. However, impermissible hindsight must be avoided and the legal conclusion must be reached on the basis of the facts gleaned from the prior art.” M.P.E.P. ch. 2142 (Rev. 2, May 2004). The governing Federal Circuit cases are equally clear.

A critical step in analyzing the patentability of claims pursuant to [35 U.S.C. § 103] is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field. . . . Close adherence to this methodology is especially important in cases where the very ease with which the invention can be understood may prompt one “to fall victim to the insidious effect of a hindsight syndrome wherein that which only the invention taught is used against its teacher.”

In re Kotzab, 217 F.3d 1365, 1369, 55 U.S.P.Q.2d 1313, 1316 (Fed. Cir. 2000) (citations omitted).

The Examiner argues that it would be obvious to modify the system of *Bergano* ‘709 to add the co-propagating amplifier of *Du* because *Du* indicates that a “co-propagating amplifier reduces cross-talk.” However, *Du* actually discloses that a co-propagating Raman amplifier *increases* cross-talk. *Column 1, lines 21-32*. The invention of *Du* is directed at a way of reducing this cross-talk when using a co-propagating Raman amplifier. Therefore, *Du* certainly does not motivate one to *add* a co-propagating amplifier to reduce cross-talk (instead it discloses how to deal with *increased* cross-talk if a co-propagating amplifier is used).

Furthermore, there is no disclosure or suggestion in *Du* that modulating a non-intensity characteristic of an optical signal with a data signal reduces cross-talk when using a co-propagating amplifier. Appellants refer the Board to Column 3, lines 49-64 of *Du*, which summarizes the ways that *Du* proposes to reduce such cross-talk (also see Figures 11-13 and the accompanying description for a detailed discussion of the proposed techniques). None of these proposed techniques relates to modulating a non-intensity characteristic of an optical signal, and there is no disclosure or suggestion in *Du* that a non-intensity modulated signal

provides any advantages when using a co-propagating Raman amplifier. Therefore, even if *Bergano '709* disclosed modulating a non-intensity characteristic of an optical signal with a data signal (which it does not, as discussed above), there is no suggestion or motivation to combine a non-intensity modulated signal with *Du*'s disclosure of the use of a co-propagating Raman amplifier. In fact, *Du* teaches away from the use of a co-propagating Raman amplifier except when using those systems specifically disclosed in *Du* (which do not modulate a non-intensity characteristic of an optical signal) since these are the only situations in which *Du* recognizes that the cross-talk created by a co-propagating Raman amplifier is sufficiently reduced.

Therefore, because neither *Du* nor *Bergano '709* disclose each and every limitation of Claims 1, 13, or 23 and because there is no suggestion or motivation to combine the teachings of *Du* and *Bergano '709*, Appellants respectfully submit that Claims 1, 13, and 23 are in condition for allowance. Furthermore, the claims that depend from these allowable independent claims (including Claims 2-6, 8-9, 11-12, 14-18, 20-21, and 24) are also in condition for allowance. Therefore, Appellants respectfully request allowance of these claims.

II. The Examiner's Rejection of Claims 7, 10, 19, 22 and 25 is Improper

The Examiner also rejects Claims 7, 10, 19, 22, and 25 under 35 U.S.C. § 103(a) as being unpatentable over *Bergano '709* in view of *Du* and further in view of U.S. Patent No. 6,556,326 issued to Bergano ("*Bergano '326*").

Claims 7, 19, and 25 recite that the non-intensity characteristic of the optical carrier signal that is modulated with a data signal is the frequency of the optical carrier signal. The Examiner first states that this limitation is not disclosed in the *Bergano '709-Du* combination, which is confusing to Appellants since the Examiner argues with respect to Claims 1, 13, and 23 that *Bergano '709* discloses modulating the frequency of an optical carrier signal with a data signal. Instead, the Examiner argues that this limitation is disclosed at Column 5, lines 39-45 of *Bergano '326*, which states the following:

The data modulator 402 receives the data to be imparted to the optical signal 401 from a data source 404 and modulates the optical signal 401 at a frequency determined by a clock 405. The optical information signal 403 is transmitted from the data modulator 402 to optical phase modulator 406, amplitude modulator 407, and finally to polarization modulator 413.

As mentioned above, the fact that a signal is modulated *at a frequency* does not indicate that the frequency itself is being modulated. Furthermore, Appellants note that a similar statement (as the statement quoted above) is made about data modulator 102 of Figure 1 in *Bergano '326*, which appears to be very similar or identical to data modulator 402.² *Column 3, lines 14-21*. Regarding data modulator 102, *Bergano '326* goes on to state that the optical information signal transmitted from data modulator 102 “is transmitted to an amplitude modulator 107 which places *additional intensity modulation* on the optical information signal 103.” This clearly suggests that the data modulator 102 (and thus similarly data modulator 402) is performing intensity modulation (as argued above with reference to *Bergano '709*), not frequency modulation. Therefore, in addition to depending from an allowable independent claim, Claims 7, 19, and 25 are also allowable since none of the cited references disclose modulating the frequency of an optical carrier signal with a data signal. Accordingly, Appellants respectfully request allowance of these claims.

Claims 10 and 22 are also allowable since they require, through their dependence on their respective independent claim, modulating a non-intensity characteristic of an optical carrier signal with a data signal. Although, *Bergano '326* discloses re-modulating an optical signal with an amplitude modulator, the modulated optical signal received by this amplitude modulator (signal 103 in Figure 1 of *Bergano '326*) is *not* a signal having a non-intensity characteristic modulated with a data signal. Accordingly, Appellants respectfully request allowance of these claims.

² The data modulators of *Bergano '326* also appear to be very similar or identical to the data modulators disclosed in *Bergano '709* (and thus the arguments in this section apply equally to the claims discussed above).

III. The Examiner's Rejection of Claim 26 is Improper

The Examiner also rejects Claim 26 under 35 U.S.C. § 103(a) as being unpatentable over *Du* in view of *Bergano '326*.

Independent Claim 26 recites “modulating one of a phase and frequency of each of a plurality of wavelength distinct carrier signals with a data signal to generate an optical information signal.” As mentioned above, the disclosure of the data modulator in *Bergano '326* is very similar to the disclosure of the data modulator in *Bergano '709*. Therefore, for the same reasons given above with respect to the rejection of Claims 1, 13, and 23 using *Bergano '709* (and for the reasons given above for Claims 7, 19, and 25), *Bergano '326* does not disclose modulating a non-intensity characteristic (and specifically, either the phase or frequency) of a carrier signal (or of each of a plurality of wavelength distinct carrier signals) with a data signal.³ Furthermore, for the same reasons given above with respect to the combination of *Bergano '709* and *Du*, there is also no suggestion or motivation to combine *Bergano '326* and *Du*. Accordingly, Appellants respectfully request reconsideration and allowance of Claim 26.

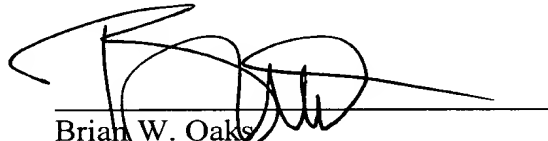
³ Again, it is unclear why the Examiner uses *Bergano '326* for this rejection since he asserts that *Bergano '729* discloses modulating the frequency of an optical carrier signal with a data signal.

Conclusion

Appellants have demonstrated that the present invention, as claimed, is clearly distinguishable over the prior art cited by the Examiner. Therefore, Appellants respectfully request the Board of Patent Appeals and Interferences to reverse the final rejection of the Examiner and instruct the Examiner to issue a notice of allowance of all claims.

Appellants have enclosed a check in the amount of \$500.00 for this Appeal Brief. Appellants believe no additional fees are due. The Commissioner is hereby authorized to charge any fee and credit any overpayment to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,
BAKER BOTTS L.L.P.
Attorneys for Appellants



Brian W. Oaks
Reg. No. 44,981

Date: November 2, 2005

Correspondence Address:

Customer Number 05073

Appendix A: Claims on Appeal

1. (Original) A method for transmitting information in an optical communication system, comprising:

modulating a non-intensity characteristic of an optical carrier signal with a data signal to generate an optical information signal;

transmitting the optical information signal over an optical link; and

amplifying the optical information signal over a length of the optical link with a co-launched amplification signal traveling in a same direction as the optical information signal in the optical link.

2. (Original) The method of Claim 1, wherein the co-launched amplification signal travels at a substantially same speed as the optical information signal.

3. (Original) The method of Claim 1, wherein the co-launched amplification signal comprises a wavelength lower than that of the optical information signal.

4. (Original) The method of Claim 1, wherein the optical information signal is amplified over the length of the optical link with the co-launched amplification signal by distributed Raman amplification (DRA).

5. (Original) The method of Claim 1, further comprising:
generating a plurality of optical information signals each comprising a wavelength distinct carrier signal having the non-intensity characteristic modulated with a data signal;
multiplexing the plurality of optical information signals to generate a wavelength division multiplexed (WDM) signal;
transmitting the WDM signal over the optical link; and
amplifying the WDM signal over the length of the optical link with a plurality of co-launched amplification signals transmitted in the same direction as the WDM signal.

6. (Original) The method of Claim 1, wherein the phase of the optical carrier signal is modulated with the data signal.

7. (Original) The method of Claim 1, wherein the frequency of the optical carrier signal is modulated with the data signal.

8. (Original) The method of Claim 1, further amplifying the optical information signal over a second length of the optical link with a counter-launched amplification signal traveling in an opposite direction as the optical information signal and the co-launched amplification signal.

9. (Original) The method of Claim 1, wherein the optical information signal and the co-launched amplification signal travel in the first direction, further comprising:

modulating the non-intensity characteristic of a second optical carrier signal with a second data signal to generate a second optical information signal;

transmitting the second optical information signal over the optical link in a second direction opposite the first direction; and

amplifying the first and second optical information signals over the length of the optical link with the co-launched amplification signal and a counter-launched amplification signal traveling in the second direction.

10. (Original) The method of Claim 1, further comprising:

remodulating the optical information signal with a transmission clock frequency using an intensity modulator to generate a multimodulated signal;

transmitting the multimodulated signal over the optical link; and

amplifying the multimodulated signal over the length of the optical link with the co-launched amplification signal traveling in the same direction as the multimodulated signal.

11. (Original) The method of Claim 1, further amplifying the signal in the optical link with a discrete amplifier.

12. (Original) The method of Claim 1, wherein the discrete amplifying comprises an erbium-doped fiber amplifier (EDFA).

13. (Original) An optical communication system, comprising:
an optical sender operable to modulate a non-intensity characteristic of an optical carrier signal with a data signal to generate an optical information signal;
an optical link operable to transmit the optical information signal; and
a distributed amplifier comprising a pump laser operable to co-launch an amplification signal traveling in a same direction as the optical information signal, the co-launch amplification signal operable to amplify the optical information signal over a length of the optical link.

14. (Original) The optical communication system of Claim 13, wherein the co-launched amplification signal travels at a substantially same speed as the optical information signal.

15. (Original) The optical communication system of Claim 13, wherein the co-launched amplification signal comprises a wavelength lower than that of the optical information signal.

16. (Original) The optical communication system of Claim 13, wherein the optical information signal is amplified over the length of the optical link with the co-launched amplification signal by distributed Raman amplification (DRA).

17. (Original) The optical communication system of Claim 13, further comprising:

the optical sender operable to generate a plurality of optical information signals each comprising a wavelength distinct carrier signal having the non-intensity characteristic modulated with a data signal, multiplex the plurality of optical information signals to generate a wavelength division multiplexed (WDM) signal and transmit the WDM signal over the optical link; and

the distributed amplifier comprising the pump laser operable to co-launch a plurality of amplification signals traveling in the same direction as the WDM signal, the co-launched amplification signals operable to amplify the WDM signal over the length of the optical link.

18. (Original) The optical communication system of Claim 13, wherein the phase of the optical carrier signal is modulated with the data signal.

19. (Original) The optical communication system of Claim 13, wherein the frequency of the optical carrier signal is modulated with the data signal.

20. (Original) The optical communication system of Claim 13, the distributed amplifier comprising a second pump laser operable to counter-launch a second amplification signal in an opposite direction as the optical information signal, the counter-launched amplification signal operable to amplify the optical information signal over a second length of the optical link.

21. (Original) The optical communication system of Claim 13, further comprising:

a second optical sender operable to modulate the non-intensity characteristic of a second optical carrier signal with a second data signal to generate a second optical information signal;

the optical link operable to transmit the second optical information signal in an opposite direction as the optical information signal; and

the distributed amplifier comprising a second pump laser operable to counter-launch a second amplification signal traveling in the opposite direction as the optical information signal, the co-launched amplification signal and the counter-launched amplification signal operable to amplify the optical information signal and the second optical information signal over the length of the optical link.

22. (Original) The optical communication system of Claim 13, further comprising:

the optical sender operable to remodulate the optical information signal with a transmission clock frequency using an intensity modulator to generate a multimodulated signal;

the optical link operable to transmit the multimodulated signal; and

the co-launched amplification signal operable to amplify the multimodulated signal over the length of the optical link.

23. (Original) An optical information signal propagated in an optical link, comprising:

a data signal modulated onto a non-intensity characteristic of an optical carrier signal;
and

the optical information signal comprising a plurality of photons absorbed from a co-launch amplification signal by a Raman effect.

24. (Original) The optical information signal of Claim 23, wherein the non-intensity characteristic of the optical carrier signal comprises the phase of the optical carrier signal.

25. (Original) The optical information signal of Claim 23, wherein the non-intensity characteristic of the optical carrier signal comprises the frequency of the optical carrier signal.

26. (Original) A method for transmitting information in an optical communication system, comprising:

modulating one of a phase and frequency of each of a plurality of wavelength distinct carrier signals with a data signal to generate an optical information signal;

multiplexing the optical information signals to generate a wavelength division multiplex (WDM) signal;

transmitting the WDM signal over an optical link; and

amplifying the WDM signal in the optical link using distributed Raman amplification (DRA) with a co-launch pump signal traveling in the same direction as a WDM signal and a counter-launch pump signal traveling in an opposite direction as the WDM signal.

Appendix B: Evidence

NONE

Appendix C: Related Proceedings

NONE